

4500

SECOND REPORT

ON

AUTOMATIC SPRINKLERS

5/26/86

MADE ON BEHALF OF

MANUFACTURERS MUTUAL FIRE INSURANCE CO., of Providence.
RHODE ISLAND MUTUAL FIRE INSURANCE CO., " "
BOSTON MANUFACTURERS MUTUAL FIRE INSURANCE CO., of Boston.
FIREMEN'S MUTUAL INSURANCE CO., of Providence.
WORCESTER MANUFACTURERS MUTUAL INSURANCE CO., of Worcester.
STATE MUTUAL FIRE INSURANCE CO., of Providence.
ARKWRIGHT MUTUAL FIRE INSURANCE CO., of Boston.
BLACKSTONE MUTUAL FIRE INSURANCE CO., of Providence.
FALL RIVER MANUFACTURERS MUTUAL INSURANCE CO., of Fall River.
MECHANICS MUTUAL FIRE INSURANCE CO., of Providence.
MILL OWNERS MUTUAL FIRE INSURANCE CO., of Boston.
WHAT CHEER MUTUAL FIRE INSURANCE CO., of Providence.
MERCHANTS MUTUAL FIRE INSURANCE CO., " "
ENTERPRISE MUTUAL FIRE INSURANCE CO., " "
AMERICAN MUTUAL FIRE INSURANCE CO., " "
HOPE MUTUAL FIRE INSURANCE CO., " "
COTTON AND WOOLLEN MANF. MUTUAL INSURANCE CO., of Boston.
SPINNERS MUTUAL FIRE INSURANCE CO., " "

BY

C. J. H. WOODBURY, INSPECTOR.

1886.

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APPENDIX

ASSOCIATED FACTORY MUTUAL

FIRE INSURANCE COMPANIES.

AUTOMATIC SPRINKLERS.

P R E F A C E .

In view of the very wide adoption of the system of automatic sprinkling, and of the competition which has arisen in the introduction of the several different sprinkler-heads, another series of tests of these several devices became necessary, and early in October last, Mr. C. J. H. Woodbury was instructed to renew the tests of sprinklers as soon as possible, substantially under the following directions.

In the present copy of these directions immaterial portions are omitted. The full directions were submitted to the representatives of the several sprinklers which it was proposed to try, and were assented to by them before the tasks were undertaken.

This report will be limited to a statement of the work of sprinkler-heads which we had been requested to test by some member or members of the Mutual Companies.

Some other heads were tested at the same time, which have not been introduced in any mills insured by this company; but since we did not find any especial merit in them calling for action of the insurance companies on their own behalf, the result of their working is omitted in this report, memoranda having been kept, by means of which we may hereafter inform members who inquire about them, as to their merits or demerits.

After giving the instructions to Mr. Woodbury to procure as many Grinnell sprinkler-heads as might be requisite,—which heads were to be considered as standards, having passed every test to which we have been able to subject them, whether quick or slow, without any leakage of such a character as to stop the melting of the solder before the valve had been fully released,—Mr. Woodbury was instructed to procure or receive such other sprinkler-heads as might be voluntarily submitted by their representatives under the terms of the instructions given. He was then directed to proceed under the following memorandum:—

“It is very desirable that we should be able to accept a sprinkler without any reservation or caution, either expressed or implied to our members, which may be so constructed that although the pressure of the water may be in the direction of the opening of the valve, yet the strain upon the fusible solder may be reduced to so small a measure as to be immaterial.”

“We desire you to make your report in very full detail, as it will probably conclude the testing of sprinklers on our behalf; at any rate, for a very long period.”

“Our attempt to maintain an impartial judgment in respect to the various sprinkler-heads, and to promote a commercial competition in their sale, has been met in such a way as to render it expedient for us to cease to reserve our own judgment as to the relative merits of the various sprinklers, and perhaps to cease hereafter to give any details of our tests or of our method of testing; but to substitute for such detailed reports the judgment of each of the Mutual Underwriters as to the relative merits of each sprinkler, for whatever that judgment may be worth, whenever we are called upon by our members to give an opinion.”

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“ The representatives of the various sprinklers which are to be subjected to these tests may desire to be present, to which you may consent, and you will please invite such representatives whenever you are ready to begin.”

“ If any objection is made to your methods of trying the sprinklers by the representatives of any sprinkler-head, you will please take note of the objection ; but you will proceed in your own method without regarding it, as this test is made on our behalf, and not on behalf of the representatives of any sprinkler, head. If any new methods of testing are suggested by such representatives, you may adopt them if you see fit.”

“ When you make your report upon these tests of sprinklers, please prepare a statistical report, which will give in figures the average loss by fire under the action of each kind of sprinkler, so far as any figures are to be obtained from which these averages can be deduced.”

“ In making these statistical tables, you will include only such losses as have occurred in fires which originated in rooms or premises where the sprinkler-heads were immediately subject to the heat at the origin of such fires ; that is to say, you will not include in your averages losses which have occurred where the fires have originated in some part of the premises unprotected by the sprinklers, and have spread from that part of the premises to the protected departments.”

“ In making these statistical tables, it would be well to give the date when each sprinkler was introduced. The deductions from the tables will not give the absolute value of each sprinkler, because our experience does not yet cover a sufficient length of time or a sufficient number of fires, especially in regard to the heads which have been invented and introduced during the last one or two years, some of which have never yet been subjected to an actual fire. But these statistical data have been asked for by members of our companies, and they are entitled to them for whatever they may be worth.”

Under these instructions various tests have been applied, both under actual fires, — by the application of graduated heat from a gas-burner, — by continuous water-pressure, and in all other ways which could be devised.

It is held that any one who reads Mr. Woodbury's report with care can form as accurate a judgment on the relative merits of the several sprinkler devices as the officers of the Insurance Companies can form ; and it is desirable that each member should thus come to conclusions based upon his own knowledge of the facts ; but if any member of any company shall hereafter ask the judgment of either of the executive officers of the several Factory Mutual Insurance Companies as to which sprinkler is the best, taking into view safety from loss by fire, immunity from leakage, mechanical construction, technical skill of the promoter in adjusting the pipes, workmanship, or any other points, that opinion will hereafter be freely given without any reservation.

We have heretofore limited ourselves to saying which sprinkler we would accept as a suitable safeguard against fire, leaving the responsibility upon the member to decide on all other matters.

Objection has been taken by certain members to this course, and fault has sometimes been found when a sprinkler has been adopted which did not prove wholly satisfactory in regard to some other point than quick action under fire. Had we objected to the adoption of certain sprinklers on other points than the working of the sprinklers under fire when new kinds were first introduced, we might have been open to the charge that we had created a preference without adequate knowledge of the facts. Suffice it that, as we gained experience in the matter, our first judgment has been sustained, whether given for or against a sprinkler, and every modification which we have suggested in construction has proved to be necessary.

This report may be considered final in respect to all the sprinklers which are now in the market on which we are called upon to report. If any new ones are invented which, in the judgment of the insurance companies, ought to be tested ; or, if we are requested by any member to test other sprinklers now in the market, or hereafter introduced, the subject will be again taken up.

In conclusion, it may be said that the member in whose mill or works any sprinkler of any kind is likely to be of service had better protect every part of such mill or works, and not to omit any part, even the wheel-pit or basement.

The only losses of any material consequence which have occurred in premises in which the automatic sprinklers have been introduced have been caused by fires which originated in some unprotected part of the mill, and in some cases in places where the fire was least likely to be expected to occur.

Had we not been withheld by considerations of cost from urging the placing of sprinklers in textile factories only where the stock is worked in a loose condition, some heavy losses would probably have been saved.

EDWARD ATKINSON,

Committee on behalf of the

Associated Factory Mutual Insurance Companies.

BOSTON, JAN. 1, 1886.

P. S. — After the copy of this report was in the hands of the printer, we received notice of the destruction of one of the mills of the Arlington Mills Mfg. Co. in Delaware, which had been wholly covered with the Parmelee sprinkler. The failure of the sprinklers to check this fire is explained in Mr. Woodbury's report. It sustains us in the caution we have always given, — namely, that, while automatic sprinklers are the most valuable auxiliary, they must not be depended upon without adequate pumps, hydrants, and other appliances. We may also call attention to the fact that while we may reduce the losses by fire to an average of ten cents on each hundred dollars insured for one year, contingencies will arise under which a mill will be destroyed by fire, in spite of all the safeguards which can be invented or applied: some of the examples of the most complete destruction having occurred in buildings wholly constructed of incombustible material.

The Parmelee sprinkler, although relatively slow in its action, has never failed before either to extinguish a fire or to hold it in check until it could be easily put out.

In July last a fire occurred in the Alexandra Mill, Bolton, England, under conditions almost identical with those in the Arlington Mill, except as to the open stairways in the latter. The fire originated from the friction of a mule, extended the length of the mule in two or three seconds, and drove the spinners from the room. Just as the last man left the room, the Parmelee sprinklers operated, held the fire in the mule where it originated, and it was then extinguished by a stream from a hydrant without further damage.

The incidents of the fire in the Arlington Mills Mfg. Co. appear to prove —

1st. That any sprinkler in which the water in the pipe must be heated before the fusible solder can yield may be too slow in its action for effective service.

2d. That even though in this case the sprinkler was slow in action, all the sprinklers opened, but too late to save the mill.

3d. That in the choice of sprinklers, preference is to be given to the most sensitive sprinkler with reference to quick action under fire; and to the sprinkler in which there is the least stress upon the soldered joint under the pressure of the water with reference to danger of leakage.

E. A., *Pres't.*

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E. A., Pres't.

Sizes of Feed-Pipes for Automatics, and number of heads allowable on each size.

DIAMETER OF PIPES.	EXACT PROPORTION OF HEADS TO AREA.	NUMBER OF HEADS IN PRACTICE.
3-4 inch, . . .	2	1
1 " . . .	4	3
1 1-4 " . . .	6	6
1 1-2 " . . .	9	10
2 " . . .	16	18
2 1-2 " . . .	25	28
3 " . . .	36	46 to 48
3 1-2 " . . .	50	70 " 78
4 " . . .	64	95 " 115

Grinnell Sprinkler 1-2 inch opening discharges one cubic foot per minute, at 3 pounds pressure at the Sprinkler.

Some patterns of automatic deliver more water than the Grinnell, and would require larger feed-pipes for same number of heads. It is understood, however, that these will in future be made nearly equivalent in discharge to the Grinnell.

To insure full work the number of heads in the third and fourth columns should have the size of feed-pipes indicated on corresponding line in first column. If a room contains 200 to 250 heads, there should be two feeders of 4-inch, or an equivalent. Should the sprinklers fail to check a fire before it spreads over an area covered by 250 heads, the capacity of any ordinary pump would be exhausted, and the proportion of pipes then becomes a question of no importance.

When feed-pipes are found less in proportionate sizes than the foregoing, they must be regarded with some doubt, and the doubt becomes more and greater as the disproportion increases.

Whenever a system is found in which there is any great variation from the figures on this card, it should be reported at once to the office.

WM. B. WHITING, *Sec'y.*

REPORT OF C. J. H. WOODBURY.

BOSTON, JANUARY 1, 1886.

TO THE EXECUTIVE OFFICERS OF THE FACTORY MUTUAL INSURANCE COMPANIES.

GENTLEMEN:—In accordance with instructions, I have subjected the automatic sprinklers offered for examination to the tests hereafter described, and herewith submit the results and conclusions reached in the course of the work.

The sprinklers, which will be alluded to by the names of the inventors, were received from Providence Steam and Gas Pipe Co. (Grinnell), Providence, R. I.; A. M. Granger, 65 Oliver St., Boston; John Gunn, Webster, Mass.; Star Manufacturing Co., 4 Post Office Square, Boston; William Kane, 2516 Kensington Avenue, Philadelphia; Walworth Manufacturing Co., 16 Oliver St., Boston; Braman, Dow & Co., 1 Haymarket Square, Boston; and Charles E. Buell, Springfield, Mass.

The sprinklers were first subjected to fire tests in a building constructed for such purposes and measuring 20 x 30 feet and 10 feet high. Six sprinklers were placed near the ceiling, in the usual manner, 10 feet apart, and 5 feet from the sides of the building; the pipes were connected to a public water-supply, whose pressure at the building was shown by a gauge to vary from 35 to 40 pounds to the square inch. Before each trial, the air was forced out of the pipes, so that the sprinklers were full of water, and any leak could be stopped.

The fires were all alike at the beginning of the trials, and the fuel consisted of half a barrel of dry hand-planed shavings, and excelsior was afterwards added as the flames died down, in quantity sufficient to keep the flames up to the same condition. Excelsior was used in this manner at all the tests, except those of the Grinnell, whose prompt action before the flames had diminished rendered the use of excelsior unnecessary.

The fires were made on the floor below the middle of the further square of sprinklers, that is 10 feet from the sides and from one end of the building, and every precaution taken to insure uniformity in the fires. These fires contained less fuel than is generally used at exhibition tests by the owners of sprinklers; but the object in this instance was to learn the operation of sprinklers at small fires, which is the first condition of large fires; and the fires were also arranged to illustrate the operation of the sprinklers in advance of the progress of a fire such as is liable to start in any class of loose stock in the process of manufacture.

The pile of shavings was set on fire in three places, and the time intervening until the operation of the sprinklers taken with a stop-watch.

Four trials were made with the door at the end of the building open, and the fifth trial with the door shut.

In the table, the time required for the operation of each sprinkler is given in minutes and seconds, and the average time contained in the right-hand column.

Time required for Automatic Sprinklers to open at Fire Trials.

	DOOR OPEN.				DOOR SHUT.	AVERAGE.
	1	2	3	4	5	
	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.
Grinnell	1 5 1 5	1 5	1 28	0 55	0 54 0 54	1 4
Grainger	0 52	1 11	0 56	3 10	1 35	1 33
Gunn	3 10	1 36	0 50	1 12	1 4	1 34
Star	2 29 2 34	3 10	3 59	7 56 8 06	4 21 4 24 4 24	4 36
Kane (excelsior) . . .	7 38	7 19 7 24	5 30 5 34	5 50	4 11	6 12
Walworth	9 28	6 46 6 47	9 20	5 57 5 59	4 8	6 55
Braman, Dow & Co. . .	5 30 5 35	9 15	10 06	10 12 10 22	2 30	7 38
Buell	7 56 stuck. 8 56	9 14 stuck. 9 24	4 30 stuck. 4 40	4 13	4 50 4 53	
Kane (reversible) . . .	stuck.	10 23	15 18	19 25		

The sprinklers were all subjected to oven tests, for the purpose of observing their behavior over a slow heat, and noting any points liable to interfere with the certainty of their action.

A street lamp was converted into an oven for this purpose, the sprinkler being attached to the lower end of a short pipe entering at the top, and supplied with connections leading to pressure gauge, water-supply, and drip, to let the air out of the pipes. The bottom of the lamp was removed, and an open tin cylinder 8 inches in diameter, and resting on a wire netting, placed underneath. The heat from a gas-burner in this cylinder produced an upward current through the lamp and out at the ventilator, surrounding the sprinkler with warm air.

The time and temperatures of opening were noted for the purpose of assuring that the heat was not raised too rapidly, as it was intended that an exposure of at least ten minutes to heat should be required to open the sprinkler. This was not in any degree a trial of the sensitiveness of the sprinklers, as the heat was not uniform, but was regulated for the different purpose of slowly melting the soldered joints in various sprinklers.

It is not feasible to determine the sensitiveness of sprinklers over a gas flame, as the continual variations in heat prevent any uniformity of conditions, and the conductivity of a thermometer is less rapid than that of brass, and the melting temperature of a soldered joint under such conditions is greater than that recorded by a thermometer as generally used in a test oven.

The glass sides of the street lamp permitted the observation of the operation of each sprinkler; and in a previous series of trials this was of value as showing the cause of the imperfect operation of several sprinklers under trial.

It is but fair to state that the Grinnell sprinklers were tested somewhat against the wishes of the Providence Steam and Gas Pipe Co.; and it must be conceded that the practical results of the protection afforded by this sprinkler render unnecessary any examination at this late day of its mechanical features for the purpose of test or criticism, but the very fact of its satisfactory record rendered it necessary that it should be used as a basis of comparison with new sprinklers which have not as yet had an opportunity to make their merits known, except in an experimental way.

The record of the successful operation of automatic sprinklers in protecting the hazardous class of risks represented by the textile mills, insured in the Factory Mutual Insurance Companies, has called attention to their efficiency in diminishing the fire loss; and naturally stimulated inventors in the multiplication of various forms of automatic sprinklers, which are frequently made without due consideration of the problems involved in the construction of a sprinkler which would at any time, after long exposure to corrosive influences, operate positively and promptly, efficiently distributing the water when exposed to the heat from a slight fire.

The constant and radical changes on the part of numerous sprinkler manufacturers indicate the extent to which their devices are unsatisfactory to themselves, even if the fact is not admitted in words.

The amount at risk upon property where automatic sprinklers are relied on for protecting the interests of underwriters and owners does not warrant the reliance upon any forms of apparatus whose operation will not, as far as possible, be assured beyond contingency.

The first sprinklers put upon the market in this country all used the fusible solder as a seal to secure a cap or plug which retained the water until liberated by the fusion of the solder. The action of such a sprinkler cannot take place until the body of metal adjacent to the soldered joint and to some extent the water contained in the sprinkler is heated to the yielding point of the solder. The sealed joint automatic sprinklers have been displaced by the present form of automatic sprinklers, wherein the water is held in check by a valve forced against its seat by means of levers or struts, secured in place by a soldered joint at the extreme end. Although this type of sprinklers has been successful in every instance when called upon to protect property against fire, yet in some forms there may be a liability of inefficient operation from several causes, all of which are of a preventable nature.

In an automatic sprinkler it is essential that the yielding of the soldered joint should not be attended with any possibility of the escaping water chilling the solder in the act of fusion and preventing further action of the sprinkler. There have been several instances of such imperfect operation of sprinklers at trials, when the sprinkler would be stuck before the valve had moved one-hundredth of an inch from its seat; but thus far none of these sprinklers have been exposed to an actual fire.

Such sprinklers would undoubtedly open after a fire had extended sufficiently to heat the water in the pipes; but such conditions imply an excessive destruction of property, and perhaps the increase of a fire to an extent beyond the ability of the sprinklers to cope with it.

To prevent leakage, a valve with sharp or rough edges is frequently pressed so firmly against a soft lead seat that it adheres, similarly as an axe will hold in the block. It is necessary that the end of the nozzle of the sprinkler should be finished to a smooth, rounding surface, avoiding sharp edges.

Neither rubber nor any of the packing compounds should be used for valve seats; for however well such materials may serve the desired purpose for resisting wear and leakage in stop valves, which are frequently open and shut, the conditions are altogether different in a valve sprinkler always kept shut until time of fire, and then must open by the force of an often feeble water-pressure directly applied upon one-fifth of a square inch.

The question is often asked as to the contingency of sprinklers being disabled by internal corrosion to an extent requiring a renewal in the course of time. In 1884, an examination of a number of Parmelee sprinklers, some of which had been in continuous service for ten years, did not result in finding any indications of internal corrosion; but, as all parts were cast brass, it was thought best to continue the matter somewhat further, and recently some Grinnell sprinklers were removed from a mill where they had been in service for three and a half years, under a water-pressure of fifty-five pounds. The inside of these sprinklers exposed to the water cast brass, rolled brass, German silver, and lead; and, in this instance, the water was taken from a river receiving the drainage from numerous manufacturing establishments, which discharge quantities of acids into the river.

The sprinklers are free from any indications of corrosion, although the water draining from the pipes was like ink; and evidently any corrosive material in solution had exhausted its action on the iron pipes, and become neutralized.

If impure water circulated through sprinkler systems, instead of remaining quiescent in the pipes, it is probable that excessive corrosion would ensue.

The outside of sprinklers is liable to corrosion from any source that will attack brass, and the treatment of difficulties from this source is a matter of design in avoiding devices whereby the corrosion of the moving parts can have the same leverage on the valve as the soldered joint.

The securing parts of automatic sprinklers should have their necessary contacts reduced to the smallest dimensions, in order that the corrosion of their surface contacts may not interfere with the movements following the fusion of the solder joints. When the bars and levers used to hold the valves to their seats have large surfaces in contact, any corrosion will cause them to stick and add to the resistance against opening after the soldered joint is fused; and instances have been known at experimental tests where rivets used in such sprinklers have been headed so much as to keep the levers from turning.

The fusible alloy used in automatic sprinklers possesses but little strength, and, like lead, has but slight tendency to return to its original form after subjected to strains. This is more noticeable in pieces of the alloy than in soldered joints; but, in every instance where excessive strains are directly applied to the alloy, a flow of the metal will take place in time.

Of two forms of sprinklers made by Henry S. Parmelee about twelve years ago, in one a plug of wood was pressed by a spring against a cylindrical bar of this alloy. A recent examination showed that the continual pressure had forced the wood through the solder, making a tube by the cold flow of the metal.

The other sprinkler contained an oval link of solder, which began to lengthen soon after the sprinkler was subjected to water-pressure, and thus permitted the sprinkler to leak. Then a spring was attached to the link for the purpose of taking up the stretch, but the plan was very sensibly

abandoned before the sprinkler was put upon the market; and Mr. Parmelee afterwards invented the sprinkler known by his name and extensively introduced, being the first and for seven years the only automatic sprinkler commercially manufactured and placed in buildings as a protection against fires.

There have been numerous automatic sprinklers using a bar or a link of solder; but the certainty of stretching and leakage has caused the withdrawal, as far as can be ascertained, of every one of these forms from the market, and the substitution of other methods of holding the parts used in keeping the valve to its seat.

Many forms of sprinklers have been made with the valve held to its seat by a strut, whose direct thrust is resisted by a plug or thimble of brass soldered into the lower part of the sprinkler. The force necessary to keep a valve water-tight against its seat exceeds the water-pressure, and the strains in an automatic sprinkler where the stresses are directly resisted exceed those in a sealed sprinkler.

In every instance which can be recalled, leakage has ensued when such sprinklers have been subjected for a long time to a water-pressure of fifty pounds to the square inch, or even less, if there are sudden fluctuations in the water-pressure. The use of screws to tighten sprinklers after they have begun to yield and leak is a makeshift, which postpones the time of breaking. When a sprinkler leaks from this cause, a new link should be put on, rather than turning the screw and adding more pressure against the old one, which already had yielded under a smaller pressure.

In automatic sprinklers, any patent must be confined to constructive devices, as the general pipe-system and the use of fusible solder are matters of common knowledge. Many important features of construction for the securing, liberation, and distribution of water are patented; but there are no broadly obstructive patents which prohibit the exercise of inventive skill in the production of automatic sprinklers in any manner comparable to the patents covering at various times salient features in telephones, sewing-machines, automatic cut-off to steam-engines, etc.

The true value of automatic sprinklers is shown by the record of what they have done, rather than any opinion based upon limited experiments as to what they might do.

The following table shows the record of the fires starting in rooms protected by automatic sprinklers, between January 1, 1877, and January 1, 1886, giving the amounts of loss and number of fires and insurance claims in connection with each type of sprinklers.

For purposes of comparison, the record is given of all fires upon property insured in the Boston Manufacturers' Mutual Fire Insurance Company during the same period, not including the automatic sprinkler fires.

Fires on Property not protected by Automatic Sprinklers and insured by the Boston Manufacturers Mutual Fire Insurance Company, including losses paid by the several Factory Mutual Insurance Companies in interest.

YEAR.	CLAIMS.	FIRES.	LOSSES.
1877	32	44	\$778,886 95
1878	26	62	233,535 26
1879	17	45	50,803 32
1880	30	80	775,008 36
1881	31	76	464,883 03
1882	32	120	866,873 93
1883	23	70	482,980 91
1884	36	56	657,136 29
1885	28	78	335,033 13
Totals . .	255	631	4,645,141 18
Average Loss per Fire			7,361 56

Fires on Property protected by Automatic Sprinklers.

	ALL SPRINKLER FIRES.			PARMELEE.			GRINNELL.			BURRITT.		
Year.	Losses.	Claims	Fires.	Losses.	Claims	Fires.	Losses.	Claims	Fires.	Losses.	Claims	Fires.
1877	none.	none.	2	none.	none.	2						
1878	none.	none.	5	none.	none.	5						
1879	512 77	1	4	512 77	1	4						
1880	1,790 19	5	12	1,790 19	5	12						
1881	1,345 40	3	15	1,345 40	3	14						
1882	2,538 72	11	27	2,156 52	9	14	282 20	1	7	100 00	1	2
1883	42,228 12	18	39	11,193 25	5	6	2,243 70	6	22	17,554 32	5	8
1884	17,001 90	18	85	3,596 32	6	20	6,113 69	7	54	258 84	2	5
1885	20,231 71	15	35	1,148 28	3	6	2,864 33	5	19	2,600 91	2	2
Total	85,648 71	71	224	21,742 73	32	83	11,503 92	19	102	20,514 07	10	17
Average Loss per Fire	382 36			261 96			112 76			1,206 71		

Fires on Property protected by Automatic Sprinklers,—*Continued.*

Year.	BISHOP.			WALWORTH.			HARRIS.			BROWN.		
	Losses.	Claims	Fires.	Losses.	Claims	Fires.	Losses.	Claims	Fires.	Losses.	Claims	Fires.
1877												
1878												
1879												
1880												
1881												
1882	none.	none.	3				none.	none.	1			
1883	none.	none.	1							9,401 17	1	1
1884				4,313 15	1	3	none.	none.	1	2,719 90	2	2
1885				10,609 36	2	3	2,917 00	1	1			
Total			4	14,922 51	3	6	2,917 00	1	3	12,121 07	3	3
Average Loss per Fire				2,487 08			972 33			4,040 36		

Fires on Property protected by Automatic Sprinklers,—*Continued.*

Year.	BARNES.			KANE.		
	Losses.	Claims	Fires.	Losses.	Claims	Fires.
1877						
1878						
1879						
1880						
1881	none.	none.	1			
1882						
1883	1,835 68	1	1			
1884						
1885			1	91 83	1	2
Total	1,835 68	1	3	91 83	1	2
Average Loss per Fire	611 89			45 91		

When sensitive sprinklers were first introduced, some apprehended that their earlier action when exposed to heat would cause excessive water damage to a much greater extent than that resulting from the slower type of sealed automatic sprinklers. The experience in the matter shows that the more sensitive a sprinkler the less the average damage by either fire or water; and it is a matter of observation that at fires, under sensitive sprinklers, fewer sensitive sprinklers open than in fires under the sealed type of sprinklers, because the operation of the former is prompt over a local heat, and not delayed until the temperature of a whole room is raised to that of the yielding point of the solder. The prompt operation of sensitive sprinklers saves fully as much in water damage as it does in checking destruction by fire.

The instances of fires whose destructive extent might have been prevented by the installation of sprinkler protection over portions of establishments occupied by processes not considered to be of a hazardous nature, as well as the record showing the low average loss from fires starting under automatic sprinklers, force the conclusion that a sprinkler protection, to be adequate, must extend over the entire building.

The Factory Mutual Insurance Companies have paid \$542,104.77 during the last four years for fires starting in portions of buildings where sprinklers were not put in, as being considered unessential on account of the safe nature of the processes.

Much of the efficiency of automatic sprinklers is probably owing to the general diffusion of the water in the air and upon unburned objects around a fire, as well as the prompt discharge of water upon a fire. It is the experience of the Factory Mutual Insurance Companies that fires communicating to the bottom of belt towers, when the machinery is in motion, have attained to destructive results,* except when protected by automatic sprinklers; and, in the latter instance, none of these fires have resulted in a claim upon the underwriters.

It is of the greatest importance that the valves in the supply-pipes of automatic sprinklers be kept open and secured by a strap passed around the pipe and one of the spokes of the hand-wheel of the valve, and the ends of the strap cemented or riveted together.

If there is any reason to close the valve, any one can cut the strap. Valves should not be sealed open with chain and padlock, as the key would generally be mislaid; and in one instance the stem of the valve was sprung by the efforts to break the chain, so that it could not be closed, and excessive water damage took place, until the gates in water-works mains were shut.

Underwriters have already paid \$494,325.67 for fires starting under automatic sprinklers, which performed no service, because the water-supply was shut off.

Since this report was prepared, a building fully equipped with Parmelee sprinklers has been destroyed by fire, resulting in a loss of \$74,249.73. From Mr. W. F. Sherman, who adjusted the loss, I learn that the fire started from a hot bearing in a mule-room on the second floor; spreading through the room, it passed by way of open inside stairways to the frame spinning-room above and the repair shop below. City water-supply, at forty pounds' pressure, supplemented by a fire-pump, was connected to the sprinklers; the valves were properly strapped open, and the fact of an unobstructed water-supply is assured, because two lines of small hose, connected to the sprinkler supply, were used during the early stages of the fire; and the sprinklers opened, which could not have been possible if there had not been a pressure on the inside to force off the caps after the solder was melted.

*The whole property has been burned, except in one instance, where the loss on a cotton mill of 15,878 spindles reached \$23,335, or about one-eighth the whole valuation of the mill.

The construction of the building and process of manufacture where the fire started were of such nature as to aid in the rapid progress of the fire, which ascended the open stairway and spread to an extent wholly beyond the control of the sprinklers, which failed to open sufficiently in advance of the fire to check its progress.

Although the Parmelee sprinkler has been supplanted by improved sprinklers, which are more sensitive to slight quantities of heat, and is not now in the market, its record has hitherto been satisfactory, and this result was not to be expected, as this sprinkler has operated satisfactorily in several mule-room fires; but in this instance, the sprinklers were not sufficiently sensitive to cope with the unusual and severe conditions imposed upon them.

It may be said, in conclusion, based upon these experiments and the results of general experience upon the subject, that there is a wide difference in the design and construction of automatic sprinklers, which materially affect their value for the purposes intended.

In the instructions preliminary to these trials, directions were given to consider the Grinnell sprinkler as a standard, being generally known on account of its wide introduction, its satisfactory operation, and immunity from leakage. In its general design of using a valve liberated by the yielding of solder away from the water, it embodies a return to the early idea of making a sprinkler containing a valve keeping the water out of the sprinkler, and away from contact with the solder; but it also includes certain features which solved previous difficulties, and rendered it a successful device, both in stability and operation. The valve-seat at the inlet to the sprinkler is placed in the middle of a flexible diaphragm, against which a deflector with a serrated edge is held by a pair of compound levers, secured at one extremity by fusible solder. When the levers are released by the fusion of the solder, the flexible valve-seat permits the valve to move without opening until the soldered joint is wholly free; thus avoiding the liability of any leaking water cooling the solder, and fixing a partially open valve. There is a distinction of great importance between the operation of piston valves, which move without opening, and the operation of the valve in the Grinnell sprinkler, wherein the valve keeps stationary against its seat without any change in relation of parts to each other during the movement preliminary to opening, instead of being obliged to slide along a surface with the chance of either leaking or meeting an excessive resistance. The area of the portion of the flexible diaphragm supported by the valve being greater than the area of the valve, the water pressure tends to keep the valve tight, as long as the resistance of the levers holds the valve in place; when the melting of the solder takes away this resistance, then the water pressure opens the valve. This simple and ingenious arrangement makes use of the same water pressure to keep the valve tight when it ought to be tight, and to force it open when it ought to be open. The soldered joint of this sprinkler is reinforced by a piece of wire in the form of the letter L, which makes a compound joint lying in three planes, and which can be readily inspected for any imperfection in soldering, and is much stronger than a plane joint soldered between two surfaces. This wire also serves an important purpose in rendering the operation of the sprinkler more positive. The end of the lever being thinner than the wire, the soldered joint melts first under the lever, but cannot move until the wire is liberated by the fusion of the solder under it. The difference in time is slight, but the joint always melts before the wire is free, and is liberated after it; and the water cannot issue from the sprinkler until the soldered joint is released, as the opening of the valve is subsequent to the movements of the levers, and not simultaneous with them; so that there is no liability that the joint will become chilled in the act of opening.

The tables of losses show that this sprinkler has operated in one hundred fires, with an average loss of one-sixth that of the fires over all other automatic sprinklers, and it needs no words

of commendation beyond the statement of the fact, that it has raised the standard of efficiency required from automatic sprinklers on the market.

Mr. Almon M. Granger of Boston sent a sprinkler to be examined, which proved to be positive in action, sensitive to slight quantities of heat, has not thus far given any indications of a tendency to leakage, and appears to be satisfactory for the purposes of protection required of an automatic sprinkler. The distributor containing the valve-seat consists of a small reaction wheel, whose revolving vanes give very uniform distribution to the water. This valve-seat is held to the orifice of the sprinkler by a rotary toggle-joint (similar to that used on an Adams hand-printing press), which is guided by a wood dowel, and held in place by a clasp, secured by a link composed of two pieces of corrugated brass soldered together. Although it contains a number of parts, their present arrangement does not involve any rivets or sliding metallic surfaces liable to adhere by corrosion.

Mr. John Gunn, of Webster, Mass., submitted a sprinkler which is very sensitive, the valve-seat in the deflector being forced against the orifice by compound levers, held at the extremity by a link made of two strips of thin sheet brass, with an offset to prevent the solder from yielding as a result of the tension upon it. The criticism to be offered upon this sprinkler is the objection against levers with riveted joints and surfaces of moving contact.

The Star Manufacturing Company of Boston submitted an improved form of sprinkler, with lever resting upon sharp edges, and the soldered joint protected by a disc. The operation of this sprinkler was satisfactory in all of the tests, and would doubtless be equally so in practice.

Mr. William Kane, of Philadelphia, sent two of his sprinklers, the one being the well-known "Eclipse" sprinkler, which has been extensively introduced in that region, and at these tests operated satisfactory, its distribution of water being remarkably uniform.

The reversible sprinkler made by the same party cannot receive the same commendation, although it contains the valuable feature, not possessed by any other valve sprinkler, of distributing the water equally well whether in an upright or pendent position. Its construction involves parts of metallic contact which must slide on each other in the act of opening, while the soldered joint is so near to the body of the sprinkler and the water contained therein that the heat was conducted away from the soldered joint, rendering the operation of the sprinkler very slow.

The Walworth Manufacturing Co. of Boston submitted their sprinklers with new links, which differ from either of those formerly used on sprinklers made by this company, both of which have been abandoned by the manufacturers, as continued exposure to water pressure caused the oval links of cast solder to stretch until the sprinklers leaked; and numerous experimental tests* with links made by soldering the arms of a U-shaped piece of brass between the arms of a similar piece of brass large enough to slide over the first one, have developed the fact of the liability that the stream of water issuing from the sprinkler simultaneously with the yielding of the soldered link will reach the solder before the parts are free and the sprinkler fully opened, and, chilling the melting solder, hold the sprinkler in a partially open position. The new link consists of two pieces of brass, bent into U-shaped pieces of equal size, and soldered together on alternate sides so that they will be free from each other when the solder becomes melted. Although this latest form of Walworth sprinkler has not received the tests of time, it will undoubtedly operate positively when exposed to heat of a fire.

* Made at different times and places by P. A. Montgomery, Secretary Western Manufacturers Mutual Fire Insurance Co., Chicago; and F. Elliot Cabot, Inspector Boston Fire Underwriters' Union; and by the writer.

Braman, Dow & Co. of Boston submitted a new sprinkler, which contains the peculiar feature of subjecting the solder to compression, instead of shearing or tensile forces. To accomplish this in the manner desired by the inventor, five levers are used, and in the numerous pins and sliding contacts there is the usual liability of disabling by corrosion. The bar of solder at the lower end of the sprinkler is in a position where it would be exposed to blows from brooms in mills, where the lint is frequently swept from the pipes. One of these sprinklers stuck after the solder was melted at one of the oven tests; and several of them in the office of the Boston Manufacturers Mutual Insurance Co., with the smaller bars of solder formerly used in these sprinklers, have crippled the solder by the forces due to the elasticity of the bent levers, without any water pressure. For the reasons here given, this sprinkler does not seem to be reliable.

Mr. Charles E. Buell, of Springfield, Mass., sent a very simple sprinkler, which contains some excellent features. The soldered joint is upon corrugated surfaces of two levers, which form a yoke when soldered together. The plate of spring brass used to hold the valve against its seat exerted so much pressure against the sharp edges of the sprinkler orifice that the valve stuck to the lead seat in over half of the sprinklers of this pattern. Later some of these sprinklers have been made with thin brass spring plates, and there has been no trouble from the adhesion of valves to their seats.

Valuable assistance was rendered at these trials by Messrs. F. Elliot Cabot and B. T. Morrison, Inspectors of the Boston Fire Underwriters' Union.

Representatives of the sprinklers under trial were present at each of the tests.

Respectfully submitted,

C. J. H. WOODBURY,

Inspector Factory Mutual Insurance Companies.

A Possible Improvement in Sprinklers.

The undersigned hereby claims, in his individual capacity, a new and useful improvement upon sprinklers; and hereby publishes it in order that it may not be patented, — as some devices which have emanated from the Mutual Companies have been subsequently patented by persons who were not entitled to them.

This device consists in adjusting a special pipe to supply one sprinkler-head upon the top of the supply-pipe, projecting upwards, so that it may be readily drained if it becomes expedient to drain the sprinkler-system when a mill is stopped, or to drain sections of a mill where it is not safe to leave the water on the sprinklers in the very coldest weather.

The opening to this vertical sprinkler-pipe, of half-inch diameter, more or less, is to be stopped by any suitable valve or seal, which may be held in its place by the fusible alloy commonly used in making sprinklers. Either one of the old devices, or any new one which may be invented, may be adapted to this purpose.

It is desirable that such a valve should possess the merit of being held to its seat by the pressure of the water itself, until it is released by the melting of the solder, so that it may be absolutely free from the danger of leakage until the fusible solder gives way.

The proposed improvement consists in doing away with or getting rid of any form of deflector or distributor, such as is now attached to the sprinkler itself, by which attachments water which emerges from the pipe is broken up into a shower or into spray before it strikes the ceiling.

We find in practice that the ceiling itself, against which the water is thrown after it has left the sprinkler, serves a very important purpose in the distribution of the water, even when any of the present forms of sprinkler are opened.

Even if the flat ceiling itself does not adequately serve the purpose, a small projection fastened to the ceiling very certainly will; and this projection may consist of a boss or cone, such as is used in ventilating systems for washing air which is to be forced into a building; a small stream of water, being projected under a suitable head against the point of a cone, is thereby broken into spray, or into a heavy shower; the air, being then passed through the spray, is thoroughly washed, and freed from impurities.

In place of a plain cone, it is proposed to substitute what might be called a fluted cone, grooved after the manner of a centre-bit, such as is used for countersinking metal or wood in order to receive the heads of screws. The grooves in this form of cone may be so devised as to give a horizontal distribution to the column of water which strikes it, so that it will completely wet the ceiling between the beams and drip from all parts of the ceiling to the floor; such being the manner in which a part of the distribution of water is now effected when the sprinklers now in common use are put to work.

This device will only be applicable to mills which are constructed in the proper manner, with wide spaces between beams, eight or ten feet on centres. When applied to the eight or ten feet bays, the pipes may be carried longitudinally on the underside of the beams, at distances of from eight to ten feet apart, according to the space between the beams. Each sprinkler-head may be projected upward toward the ceiling, and pointed toward the boss or cone in the centre-line of each bay between the timbers.

It is believed that by divesting the sprinkler of the complexity which ensues in the combination of the distributor or deflector with the valve and fusible seal in the same head, that the adjustment of sprinklers may be made more simple. It is hoped that some inventor will apply the suggestions herein made, on which there is now no patent existing, so far as we know, and upon which no patent can be taken out after this publication of the proposed method, as it is the intention of the undersigned to employ an agent to put this method into practice, in order that it may not hereafter be patented by some one else, on the ground that the original inventor had failed to put it into use.

From the writer's experience, it appears to be about as difficult to make an invention a part of the public property as it is to get a suitable patent upon it, or a little more so.

EDWARD ATKINSON,

(President Boston Manufacturers Mutual Fire Insurance Co.)